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ABSTRACT

The idea of flight and space travel are not new, but tne technologies which make them possible are very recent. This booklet considers time, space, and spirit related to living in space. Time refers to a sense of history; space refers to geography; and spirit refers to life and thought. Several chapters on the history and concepts of flight and space sciences, a time line related to the concepts, a map of the important geography related to these concepts, a glossary of important terms, and a list of several study suggestions are included. (CW)

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Living in Space

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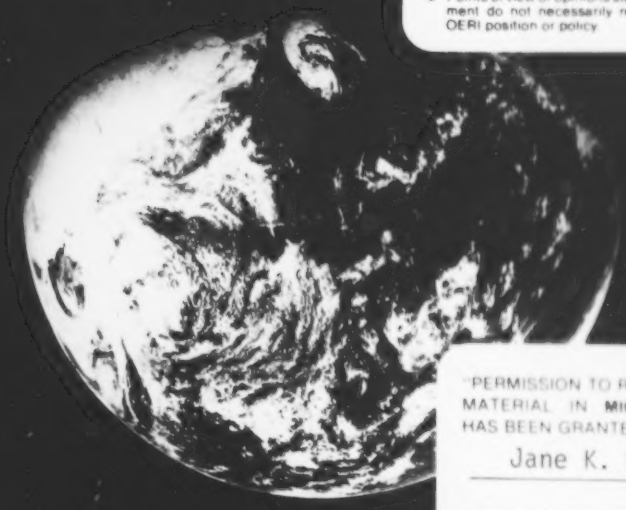

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A HAWKHILL LEARNING POWER BOOK

2

TIME, SPACE AND SPIRIT

KEYS TO SCIENTIFIC LITERACY

To the student,

This short book will help you understand our modern world. It has changed a lot since your parents were born. Even more since you were born. And it will change still more–much more–in your lifetime.

What is behind most of these big changes? Two things. Science and technology.

What can you do about it? The first step is to understand more about science and technology and how they connect with our world. Especially the ever-growing world of free democratic societies. One way to do this–the way this book follows–is to look at the world from three angles: *Time, Space* and *Spirit*.

Time means history. You can learn how science and technology have worked in the past and are working today.

Space means geography. You can learn where important things happened in the past and are happening today.

Spirit means life. The life of the mind. You can learn the key words, concepts and ideas that power science and technology (and society) today.

This book teaches about science, technology and society from all three of these angles–*Time, Space* and *Spirit*.

Read on.

This book belongs to:

Living in Space

Bill Stonebarger
Illustrations by Lin Haley

Hawkhill Associates
Madison, Wisconsin

This book is one of a series of sixteen Learning Power Books in the *Time, Space and Spirit–Keys to Scientific Literacy* series. It is designed to accompany the video program of the same name.

The *Time, Space and Spirit–Keys to Scientific Literacy* series was written and produced with consultation from the History of Science Department at the University of Wisconsin-Madison.

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Part 1: A Short History of Space Exploration

"in the cradle"

"The earth is the cradle of the mind,
but you cannot live in the cradle forever."

the keys to a new kingdom

So wrote the great Russian space visionary Constantin Tsiolkovskii in 1895. In Moscow today a soaring monument to Tsiolkovskii overlooks the city, one of two cities in the world holding the keys to the new kingdom. The keys that will let humankind stand up and step out of that cradle.

a kingdom of the future

Today, after thousands of years of human culture on this small spaceship called earth, there is little question that Tsiolkovskii was right–the future belongs to the space pioneers.

who will lead?

Which city, Moscow or Washington, leads the way in this new frontier will make a difference–a big difference–both in space and back on our home base, earth.

historic moment

Let's take a brief look first at how we got to this historic moment. I say historic as the understatement of the century. Of the millenium. Many would say the only comparable moment in earth history was the time when creatures first crept out of the comfortable environment of the ancient ocean to dare try breathing air, and living on the land.

It took these first amphibious creatures millions of years to effectively make the transition from water to air. And a few million years more to completely liberate themselves from spending some part of their

lives back in sea water. In fact, no living creature has yet completely cut itself off from seawater. For proof of this, taste your own tears, or the blood from your cut finger. That salty taste is from the ancient ocean we all still and always carry within our every living cell.

from air to space

In only a few decades, however, the human race has shown the possibility of moving into another world. Out away from earth. We have already proven the possibility of living in space!

Here are some of the steps we took to get there.

human thought and consciousness

After that first emergence of life from the sea, some would claim the next monumental step forward was the emergence of human thought and consciousness. Modern scholars debate how long ago this happened. Some say as long as a few million years ago. Others say only about six thousand years ago, about the time writing was invented during the first great civilizations in Asia, Africa, Europe, North and South America.

ages of exploration

We do know that in those uncounted years of human consciousness, humans have discovered, explored and colonized every available spot on this planet that is capable of supporting human life. We also know that some of the time some of the

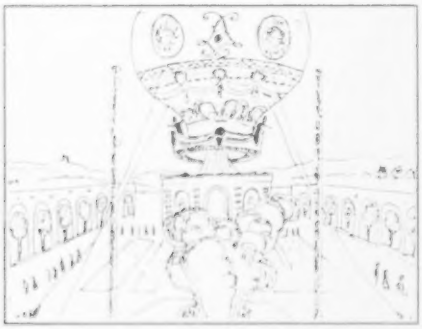
people dreamed of a life beyond earth. And we know that now in the late twentieth century human beings are taking the next logical step forward and outward. The steps needed to discover, to explore and soon to colonize permanently other spots in the universe.

science fiction writers

Pioneers like Tsiolkovskii, along with science fiction writers like H. G. Wells and Jules Verne foresaw this inevitable step in the last century. They could not actually lead the way into space, however, since the technology to take this historic step had not yet been developed.

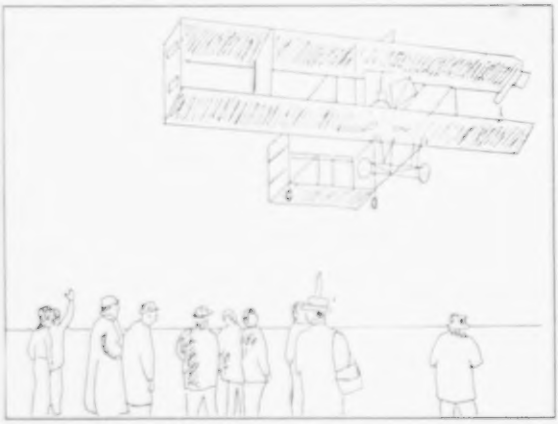
lighter-than-air balloons

Lighter-than-air balloons were first launched in the late 1700s, about the time of our American Revolution. Benjamin Franklin watrched one of these first balloons ascend into the sky at Versailles, France. When another onlooker asked what use such balloons could possibly have, Franklin answered, "Of what use is a newborn babe?"



the Wright brothers

Three years into our own twentieth century, two bicycle mechanics from Dayton, Ohio named Wilbur and Orville Wright proved that humans could leave the earth to fly in the air like birds. At Kitty Hawk, North Carolina, Wilbur watched his brother Orville leave the earth in their newly built heavier-than-air, gasoline-powered vehicle. The new "air" plane stayed aloft only long enough to travel one hundred twenty feet (this is five feet less than the length of the space shuttle cabin that leaves earth today on a regular schedule). For the Wright brothers, and their fellow earthlings, it was far enough to make a good beginning.



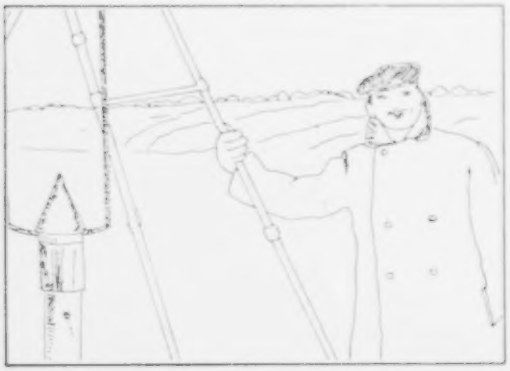
an airplane needs air

Airplanes, however, need air. To leave earth you had to have a machine that could power itself in the absence of air.

An American engineer, Robert Goddard, was one of the first to take practical engineering steps toward building such a machine. The Chinese had invented rockets many centuries before. Until Goddard, however, rockets had never been used for much except fireworks displays.

first liquid-propelled rockets

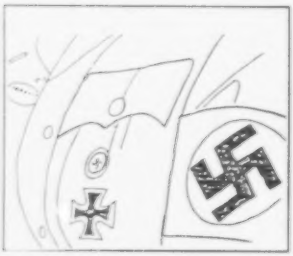
Since rockets carried their own air inside, Goddard realized that rockets could be the power source to move into space. On a golf course in Amherst, Massachusetts on March 16, 1926, Goddard launched the first liquid-propelled rocket. To the dismay of some neighbors, the rocket reached a very noisy, fiery altitude of forty-one feet and a speed of sixty miles per hour. Again, not very high, and not very fast, but a very good beginning.



rockets don't need air

Goddard's rockets never came close to actually leaving earth or going into orbit. But they did prove a point–rocket power worked and it did not need any outside air. All we had to do now, he pointed out, was improve them. And so it happened, even faster than he imagined it would.

V-2 rockets in World War II



The biggest leap forward, sad to say, came during the Second World War, and in the country that was defeated, Germany. Even sadder to say, some of the drudge work needed to build large V-2 rockets meant to devastate London was done in underground factories by slave laborers under the Nazis. Some of the V-2 rockets did land and explode in Britain, but fortunately the war ended before the V-2 rockets were perfected enough to seriously affect the outcome.

German rocket engineers come to U.S.

The scientific and engineering expertise in rocketry that Germany built up during the war did not disappear in peace. Some of the German scientists came to this country and some went to the Soviet Union.

Wernher von Braun

One of the most famous of the German scientists, Wernher von Braun, headed the first U.S. effort to build rockets powerful enough to leave the earth's gravitational field. By 1948 the U.S. had built and tested a two-stage rocket that reached an altitude of 244 miles.

Sputnik I

The honor of building and launching the first rocket to put a satellite in orbit went to the Soviet Union when they shocked the world with the launching of Sputnik I on October 4, 1957.

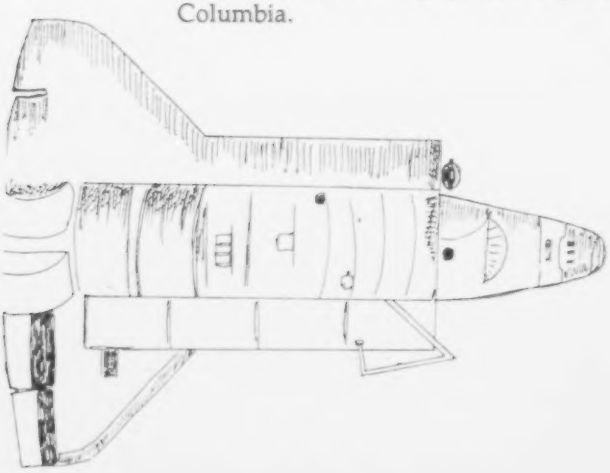
After a number of humiliating failures, the U.S. effort to leave the earth succeeded a few months later in January of 1958 when the first U.S. satellite was launched and put into earth orbit.

first man in space

The Soviet Union also put the first human being into space orbit. Cosmonaut Yuri Gagarin left earth on April 12, 1961 to begin the era of human space exploration.

first space shuttle

Twenty years later to the day, U.S. astronauts John Young and Robert Crippen flew into space in the first reusable spacecraft, the first practical machine for colonizing space, the space shuttle Columbia.



Kennedy promises to put man on moon

During that twenty years, both the U.S. and the USSR accomplished much in space flight and discovery. Responding to the Soviet challenge of Sputnik, in 1961 President John Kennedy promised that "This nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to Earth."

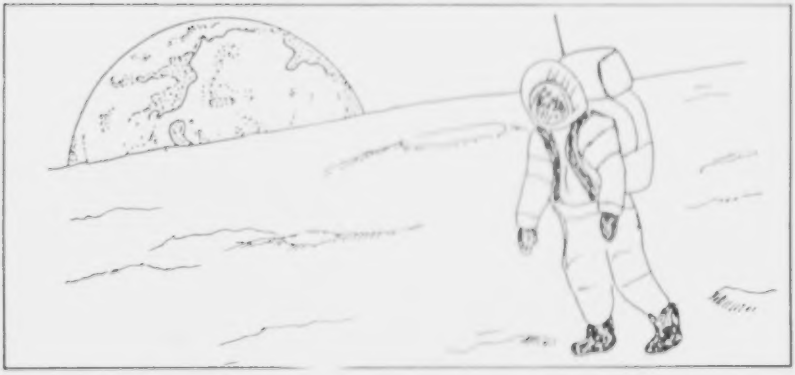
The goal was given a named, Project Apollo.

It was a bold challenge, and many at the time thought it a foolish, even foolhardy, one. Amazingly enough, Project Apollo succeeded.

"the Eagle has landed"

Many of us remember vividly that summer day in 1969 when we shared with millions of people around the world the tense moment, live on radio and television, "Houston, Tranquility base here. The Eagle has landed."

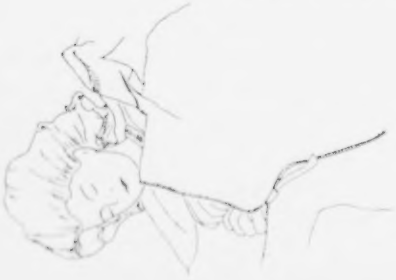
And then the next day, Neil Armstrong put the first human footprint on the moon. "One small step for man, one giant step for mankind."



The first flight to the moon was so dramatic, it almost spoiled us for the achievements that followed. Space travel, to many, began to seem almost routine and humdrum.

"four rooms with earth view"

Not so for the astronauts and cosmonauts, however. Having reached the first heavenly body safely, the next step into space was a move to establish a semipermanent space structure in earth orbit. The U.S. started with a project called Skylab. NASA called the first station they put into orbit, "four rooms with earth view."

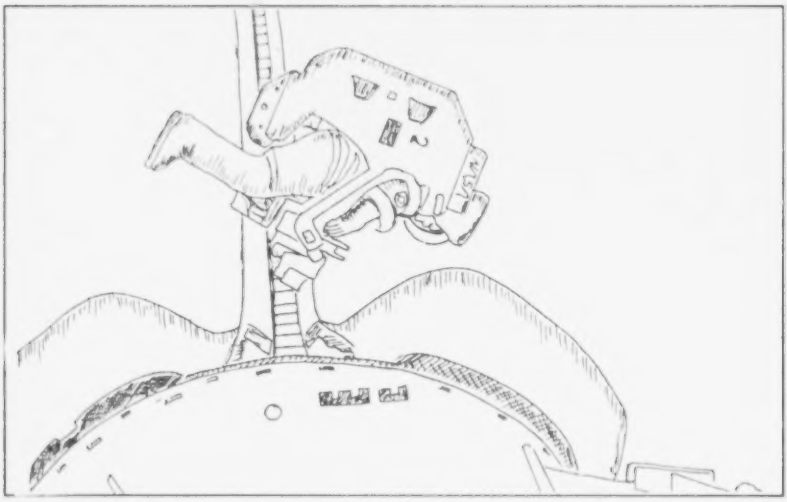


Astronauts ferried up to Skylab three times and stayed on board this miniature moon for up to almost three months at a time. While there, in zero gravity, they performed a host of important experiments on how it was to live in this strange new world of outer space. How to do ordinary things like brush your teeth, eat dinner, sleep, take a shower and exercise.

still needed umbilical cord

The astronauts could also now take dramatic space walks, though here, like human embryos, they still had to be tethered to the mother ship by a nylon umbilical cord.

In the 1980s decade The U. S. launched the space shuttle, liberating us still further. Astronauts–men and women (Sally Ride was the first woman astronaut)–were able to fly into space in a spacecraft and return in the same spacecraft.



plans for space colonization

While in space they were now able to leave the spaceship and move around on their own. Like toddlers still, but on their own, no umbilical cord.

Today both the USSR and the USA as well as other countries are planning future space colonies. They don't want only to explore space. They want to build and colonize new territories in space. In much the same way the Pilgrims came to *live* in America not long after America was first discovered. The explorers, in other words, scout the way. The colonists move there to make their home, to live in space!

space colonies from small to large

In this case, however, the kinds of homes they expect to have in the new space colonies will be different from the ones they leave behind on their home planet, earth. The early space colonies, like the early colonies in America, will be small and cramped. As time goes by, however, just as the small colonies in America eventually became Boston, New York and Washington, so too the small colonies in space will eventually become ... we don't know what.

failures and tragedies

And just as there were many failures and tragedies in the exploration and colonizing of this planet earth's continents and islands and archipelagos, so too there have already been failures and tragedies in humankind's movement into space.

Three of the first group of U.S. astronauts burned to death in a tragic launch pad fire in 1967. The USSR lost cosmonauts in more than one tragic accident.

Christa McAuliffe

Most recently of all came the explosive end of the space shuttle Challenger, planned to carry the first citizen-astronaut into space, teacher Christa McAuliffe.

exploration goes on

Just as the tragic accidents of past explorations did not stop new pioneers, so the tragedies that have been, and the tragedies that will come in space exploration and colonization, will not stop our generation and the generations to come.

Judith Resnik

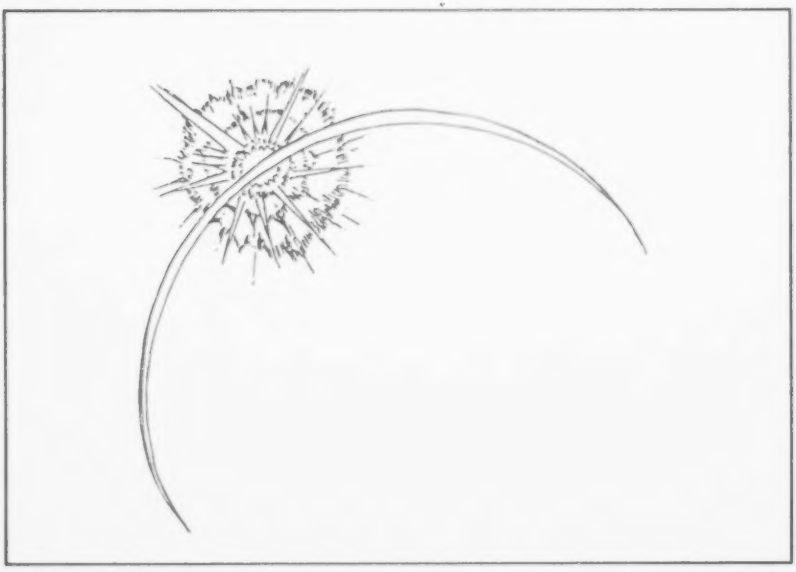
As Judith Resnik, one of the crew who died in the Challenger, said, "You launch, not knowing what is going to happen. And that is the challenge you have to take. Without doing that, one would never accomplish the work one sets out to do."

"I touch the future, I teach"

Christa McAuliffe expressed better than anyone the enduring legacy of all pioneers. "I touch the future. I teach."

So, too, all the space pioneers will teach all of us the future of our world. And the future of our species.

Part 2: "I touch the future. I teach."



welcome to Taurus

Welcome to Taurus. Population 9,280. Which does not include two thousand purebred Rhodesian Ridgeback puppies, five thousand purebred Siamese space cats and a few million assorted tropical fish. Most of these animals are bred and nurtured as export items, helping to support this new space colony.

luxury items

As Alice Donovan, local Taurus historian, points out, "It's pretty much the same way it was in the early days of America, when luxury items like beaver fur hats were the biggest exports."

retail and wholesale

These exports mostly go to earth, but a few are also wholesaled to other space colonies beginning to be established in nearby L-5 stations. These colonies are only the tip of the iceberg, of course, as they used to say back on earth where they had icebergs.

biotechnology

The really big industry here on this remote outpost space colony is biotechnology. Early settlers found that the low-gravity conditions, combined with almost perfect ecosystem control, helped to give them huge competitive advantages over earth-based manufacturers of certain drugs.

new drugs

Especially the new drug, DYA (Determine Your Age), the economic mainstay of Taurus. And by far the most popular pharmaceutical on earth.

fountain of youth

DYA is the long-sought "fountain of youth." It is a drug that seriously retards aging. Even better, in the correct dosages it lets you determine what age you want to be. For as long as you want to stay at that age.

life spans of two hundred years and more

DYA is bringing life spans of two hundred years and more. That is, in the old fashioned way of counting things. DYA people don't worry much about how old they are. Why bother when what would formerly be called a hundred-and-ten-year-old woman or man plays in tennis tournaments, runs marathons, climbs mountains and takes space walks regularly. Sometimes those walks are on Taurus and sometimes they are back on earth–mostly a wilderness preserve now.

discovered by serendipity

DYA is another example of a drug discovered by serendipity in the early days of experimental science in Taurus laboratories. It is also a drug that, needless to say, has changed life dramatically back on spaceship earth.

NASA physician

So much so that some, even now, still quote the visionary physician, Dr. Philip Johnson, head of medical research at NASA a few decades ago. In those days he told interviewers, "If you assume that we're going to go farther and farther into space, the ultimate as far as I'm concerned ... the Bible predicts it–man will leave earth. In terms of the Bible, we're going to heaven. God will bring us up to heaven."

They are not quite to heaven yet on Taurus. But they are on the way someplace exciting and someplace incredibly productive.

"what's a heaven for?"

More conservative folk prefer to quote the nineteenth century poet, Robert Browning. "Ah, but a man's reach should exceed his grasp, or what's a heaven for?"

The preceding is science fiction today, of course. Many sober scientists think it is much closer to reality than we realize.

Sally Ride

Astronaut Sally Ride, for instance, said, "It's almost impossible to guess what will be possible in ten years. If you had asked someone thirty years ago whether thirty years from then we would have had people on the moon; we would have had a space station; we'd have something like an airplane that goes into earth's orbit, spends a week there, then lands just like an airplane; nobody would have believed the person who predicted that."

can't predict future

"I think we're going to be in the same situation ten years from now, twenty years from now. We're not going to be able to predict what we'll be doing. One thing that we can say is that space travel will be a very routine part of our normal lives. We'll have a lot of people who are working, carrying out experiments on a day-to-day basis."

How will it be–actually–not just visiting, but living in space?

expect the unexpected

We can speculate. We can extrapolate from the limited experiences humans have already had orbiting the earth, and walking on the moon. While doing so we need to realize that the full reality twenty, thirty, forty, a hundred years from now will be as different as the speculations the Pilgrims might have made about how people would live in twentieth century America.

speculations of your grandparents

Or closer to our time the speculations and dreams of my own grandparents who were born before automobiles, airplanes and radio and television were invented.

Starting with the present, let's look at the reality of space colonization and then try to envision the possible next steps.

next step is space station

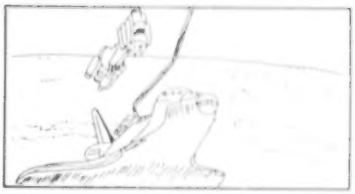
Dr. Philip Johnson thought it will go this way. "Our next step is a space station. USSR already has had a space station. It's a two-man space station and up to three can visit. Pretty small, but it's been up there for several years. Any one crew has spent as much as six months living there.

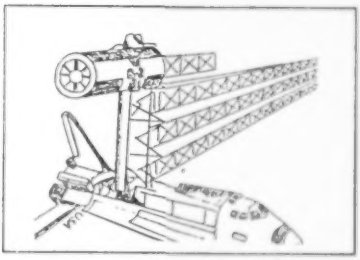
like going to Antarctica

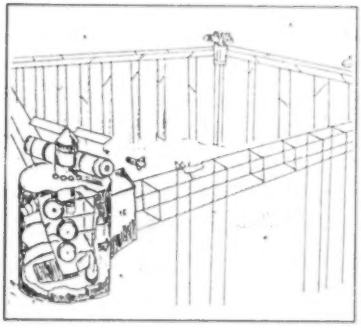
"Our space station, when we launch it in the early 1990s, we think that people will stay up for a month to three months, come back, maybe spend three months on earth, maybe go back again. It's going to be a lot like people do on supertankers. Go to Antarctica, spend three to six months there, come back."

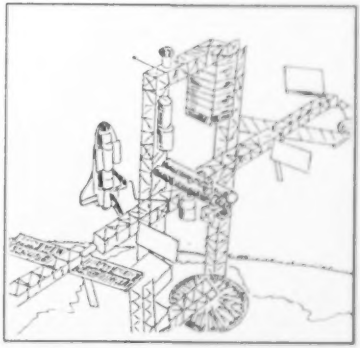
close orbit around earth

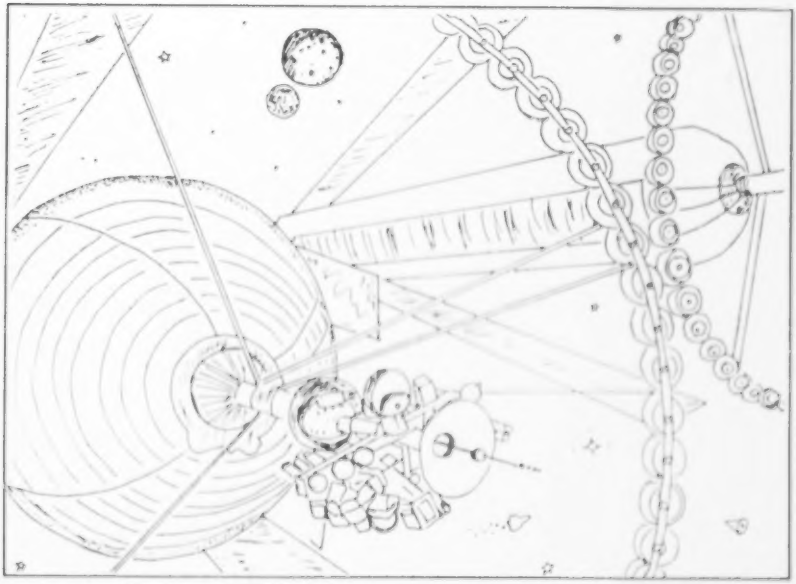
These first space stations will be in close orbit around earth. Astronauts already have the tools, the techniques and the materials ready to assemble these stations.









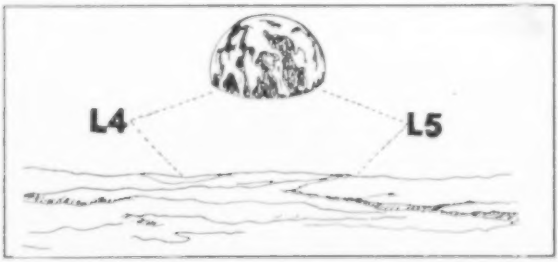


no gravity makes construction easier

Since there will be no gravity in the space stations, they can add on rooms, laboratories, warehouses, factories indefinitely. The construction would in some ways be much easier than earth because of the no-gravity environment. You would not need any large cranes to lift steel girders. In fact you would not need steel girders since the buildings would not have to support themselves against gravity. Given enough time this could lead to quite large space stations.

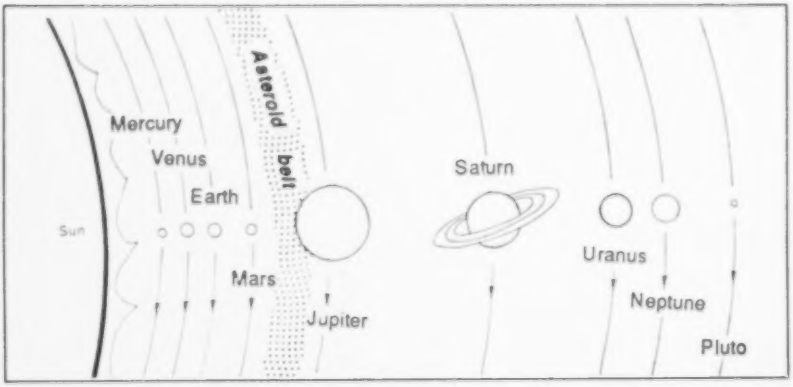
L-4 and L-5 sites

It is more likely, however, that the first large space colonies will be built farther out. Perhaps at locations called L-4 or L-5. These are two points where the space station could hover at rest with respect to the earth and to the moon.



colonizing the asteroid belt

Colonies might also be established on the moon itself. And soon thereafter on Mars as well. Most important of all in the long run will probably be the large asteroid belt between Mars and Jupiter.



Some day there may be hundreds of space colonies here, some of them as large as a large city today.

construction materials from moon and asteroids

It is also likely that these larger space colonies will not be built with materials expensively lifted out from earth. Instead builders will gather raw materials from the moon, and later from the abundant resources of Mars and the asteroids.

Pilgrims didn't import soil and water

Again, there are many precedents. In the first colonies here in the New World of America, a few hundred years ago the Pilgrims only brought a few tools and seeds with them from England and continental Europe. They didn't import soil and rocks and water.

different designs

To build these larger space colonies, many designs are now being considered. One possibility would be a large rotating doughnut shape. People would live and work in the far, gently rounded circumference of the doughnut.

A colony like this would rotate in order to create an artificial gravity since our bodies are built to work best in that kind of earthlike environment. The gravity at the circumference where people live most of the time would probably be the same as on earth. As you moved *up*–or we should say *in* from–the circumference toward the center of the rotating colony you would experience less and less gravity. Spe-

cial laboratories and factories could be established at or near the center of the doughnut, or just floating nearby, where there would be little or no gravity.

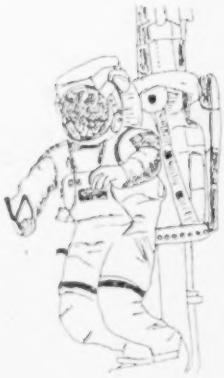
artificial gravity

In itself, this controlled gravity situation would lead to interesting new possibilities for arts and recreation as well as manufacturing and science.

new frontiers in the arts

Dancers could soar in astonishing new choreography. Mountain climbers would find the going easier the higher they went. (Yes, it could be big enough someday to have high mountains!) Musicians, artists and lovers might find new ecstacy and inspiration liberated from the heavy burdens of gravity.

euphoria of weightlessness



Sally Ride says of weightlessness today, "There's a whole aspect to space travel they just can't simulate. The feeling, it's almost like a euphoria, something that your body is not used to, has to adapt to, but really enjoys once it has adapted to it. And the view looking back to earth is spectacular."

risks, mistakes and tragedies

In the early days of these new space colonies there will no doubt be mistakes. There will be failures. Even catastrophic ones. Though the mistakes and catastrophes will be no greater, and probably less catastrophic than the many failures in first colonizing North America, for instance.

There will be another big advantage–no native cultures will be destroyed or displaced or demoralized.

visions of future

No doubt for some the colonies will be too small and confining at the beginning. Probably within your own lifetime these colonies will grow quite large, however. Some predict that some day they could even rival the size of a large state, or even an entire country or even, believe it or not, spaceship earth itself!

Visionaries like Princeton professor Gerard O'Neill predict, and are planning now, for just such events.

NASA's Dr. Johnson put it this way, "I think eventually mankind will leave earth. Whether earth will be in good shape as we leave, or whether it will be a nice place to come back to, I don't know.

humankind will leave earth?

"But I will predict that we will go to other planets to live and that we will have populations going just as, say, the Pilgrims came to the US to populate and Englishmen to Australia to populate."

Perhaps you will be among the pioneers.

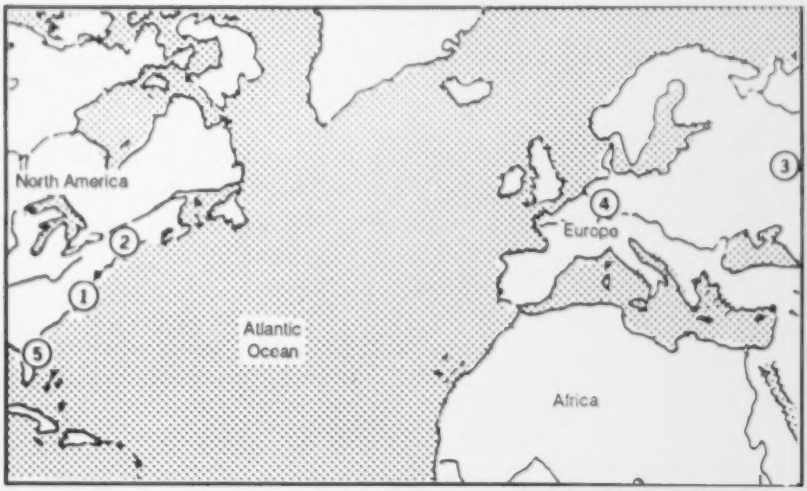
TIME ...

To understand the world of today it helps to know something about the world of yesterday. Kings and queens, wars and famines, presidents and paupers have all played a part. But more important than any of these in changing the past world into the world of today has been science and technology. The time line below will help you place important events and people in historical time.

EVENTS IN WORLD HISTORY		EVENTS IN SCIENCE & TECHNOLOGY
	1900	*1900*
		1903 Wright brothers fly first heavier-than-air plane
1914-18 World War I		
		1926 Robert Goddard sends up first liquid-propelled rocket
1939-45 World War II		
		1942 V-2 rockets in Germany
	1950	*1950*
1950-53 Korean War		**1948** 2-stage rocket in U.S.
		1957 USSR sends Sputnik I into earth orbit
		1961 USSR sends first cosmonaut into orbit
		1969 USA sends men to walk on moon
1966-73 Vietnam War		**1986** space shuttle Challenger explodes

SPACE ...

There is a saying, "If you don't know where you are going, any road will get you there." One of the important parts of knowing where you are going is a knowledge of geography. The map below will help you to locate the important events and people discussed in this book.



1. Kitty Hawk, North Carolina — Where the Wright brothers, bicycle mechanics from Dayton, Ohio, flew the first heavier-than-air flying machine in 1903.

2. Amherst, Massachusetts — Where Robert Goddard fired the first liquid-propelled rocket on a golf course in 1926.

3. Moscow, USSR — Capital of the Soviet Union, one of the two leading countries in space exploration and colonization.

4. Germany — Where V-2 rockets were designed and assembled, and then fired into England toward the end of the World War II.

5. Cape Canaveral, Florida — Kennedy Space Center. The launching site for U.S. space shuttles.

SPIRIT ...

Time and space are meaningless without spirit. Spirit is the part in each of us that understands. The part that sees connections between words and things–connections that surprise and make sense. Study the key words, concepts and ideas below so that you can understand how time, space and spirit worked in the past–and are working today.

Apollo Name of the U.S. space program which sent the first men to the moon. (p. 8)

Armstrong, Neil The first man to walk on the moon. (p .8)

asteroids A group of heavenly bodies especially numerous in the spaces between Mars and Jupiter. Likely spots for future space colonies. (p. 19-20)

astronaut Peerson who has travelled to outer space. Used especially for men and women who have travelled in U.S. space program. (p. 9, 11, 18)

Braun, Wernher von A German rocket engineer who came to the U.S. after World War II and headed up our program to develop rockets that could reach orbit in outer space. (p. 6)

Challenger U.S space shuttle that exploded in 1986 killing all astronauts, including the first civilian to fly in a space shuttle, teacher Christa McAuliffe. (p. 11-12)

Columbia The first U.S. space shuttle to fly into orbit and land on earth again. (p. 7)

cosmonaut People who have travelled to outer space. Term is used especially for men and women who have travelled in USSR space program. (p. 7, 11)

Eagle Name of the first human-made vehicle to land on the moon in 1969. (p. 8)

extrapolate To predict some future event by assuming a continuous change similar to changes in the past. (p. 16)

Gagarin, Yuri	First human to orbit the earth. Travelled in USSR space capsule April 12, 1961. (p. 7)
Goddard, Robert	American rocket engineer who designed and tested the world's first liquid-propelled rocket in 1926. (p. 6)
L-5 location	Places in space equidistant from the moon and earth. Along with L-4 locations, good sites for space stations or colonies where they could remain in stationary orbit. (p. 13, 19)
McAuliffe, Christa	A junior high school teacher from New Hampshire. The first citizen to attempt space flight. Killed when the space shuttle Challenger exploded on lift-off in 1986. (p. 11-12)
Moscow	Capital of the USSR, one of the two leading countries in space exploration and colonization. (p. 1)
NASA	National Aeronautics and Space Administration. A branch of the U.S. Department of Commerc responsible for all civilian space work of the U.S. Government. The U.S. military and private companies are also involved in space activities today.
Ride, Sally	First U.S. woman to travel into space orbit. (p. 9, 16, 21)
Skylab	First U.S. orbiting space station where astronauts lived and worked for extended periods. (p. 9)
space colonies	Places in space where people would establish permanent living areas. (p. 10-11, 13-14, 19-22)
spaceship earth	Name of our planet earth. Coined to symbolize the common environment all people on earth must share. (p. 2)
Sputnik I	The first object to be sent into earth orbit. Sent out by the Soviet Union on October 4, 1957. (p. 7)
Tsiolkovskii, Constantin	Russian space engineer and visionary (1857-1935). (p. 1)

V-2 rockets — Rockets built by the Germans in World War II. Designed to carry explosives and to bomb England. (p. 6)

Verne, Jules — French novelist (1828-1905) famous for science fiction, including space travel and life in space colonies. (p. 4)

Wells, H. G. — English writer (1866-1946) famous for science fiction about space flight, much of which turned out to be prophetic. (p. 4)

Wright brothers (Orville and Wilbur) — Bicycle mechanics from Dayton, Ohio who successfully built and flew the first powered heavier-than-air machine at Kitty Hawk, North Carolina in 1903. (p. 5)

zero-gravity — A condition such as astronauts face in orbit where there is no gravity. (p. 9, 18-21)

In addition to the above, *Living in Space* also teaches about other important people, places, things and ideas. Often you can figure out the meaning of a new term by seeing how it is used in context. Make sure you know the meaning of the following words. For help, check the pages listed in this Learning Power Book, or if necessary, a dictionary or encyclopedia:

amphibians (p. 2); **Antarctica** (p. 17); **biotechnology** (p. 14); **Browning, Robert** (p. 15); **China** (p. 5); **circumference** (p. 20-21); **Crippen, Robert** (p. 7); **embryo** (p. 9); **Franklin, Benjamin** (p. 4); **Germany** (p. 6); **Jupiter** (p. 19); **Kennedy, John Fitzgerald** (p. 8); **Kitty Hawk, North Carolina** (p. 4); **Mars** (p. 19); **O'Neill, Gerard** (p. 22); **orbit** (p. 7, 16-18); **Pilgrims** (p. 17, 20, 23); **Plymouth, Massachusetts** (p. 16); **Resnick, Judith** (p. 11); **serendipity** (p. 15); **umbilical cord** (p. 9-10); **USSR** (p. 1, 7-8, 10, 17); **Young, John** (p. 7).

STUDY SUGGESTIONS ...

1. Writers and artists have long expressed interest in the future of space travel. How do the visions of Leonardo da Vinci, H. G. Wells, Jules Verne and others compare with the reality of space exploration?

2. One of the most startling statements in this book is the quote from Dr. Philip Johnson of NASA who claims "eventually mankind will leave earth." Do you agree with him? Why or why not? If it were to happen, what would earth itself be like? A large wilderness park?

3. The book *Murmurs of the Earth* documents the contents of a record sent aboard Voyager spacecraft as messages to extraterrestrial beings, should they ever find Voyager. The record includes photographs, music and greetings in a number of languages. Selecting a sample of human experience may be just as important as having it received. If you were chosen to select a sample of life in your own time and place, what would you choose? Defend your choices and compare them to those of your friends and classmates.

4. The tragedy of space shuttle Challenger will be long remembered. One of the lasting legacies of Christa McAuliffe, the first citizen astronaut, is her statement, "I touch the future. I teach." Discuss these words. How do they apply to not only teachers but to parents, explorers, scientists and students.

5. Opponents of the space program object to spending billions of dollars on space research when there are so many social problems that need solving at home on earth. Evaluate and discuss these objections. Are they different from those that people might have brought forward in years past for spending time and effort to explore the surface of the earth when the home countries had so many urgent problems?

6. Investigate the advances in communication due to space satellite technology. Some have pointed out it makes the world a "global village" since messages can be sent and received in fractions of a second anywhere on earth. Compare the cost of sending messages at fifty year intervals over the past two hundred years.

7. The book talks of space colonies large in size. Some visionaries, like Gerard O'Neill (see bibliography) confidently predict colonies that could rival earth itself in size. Discuss and debate.

Bibliography ...

Baker, Wendy. *Americans in Space.* New York: Crescent Books, 1986.

Braun, Wernher von, and Frederick I. Ordway III. *The Rockets Red Glare: An Illustrated History of Rocketry Through the Ages.* New York: Doubleday, 1976.

—*Space Travel, A History.* New York: Harper & Row, 1985.

Clarke, Arthur C. *The Promise of Space.* New York: Harper & Row, 1968.

—*July 20, 2019: Life in the 21st Century.* New York: Macmillan, 1986.

Cortright, Edgar M. , ed. *Apollo Expeditions to the Moon.* Washington, DC: Scientific and Technical Information Office, NASA, 1975.

Davis, Joel. *Flyby: The Interplanetary Odyssey of Voyager 2.* New York: Atheneum, 1987.

Harding, Richard. *Survival in Space.* New York: Routledge, 1989.

Horowitz, Norman H. *To Utopia and Back: The Search for Life in the Solar System.* New York: W. H. Freeman, 1986.

Joels, Kerry Mark. *The Mars One Crew Manual.* New York: Ballantine Books, 1985.

Kennedy, Gregory P. *Vengeance Weapon 2: The V-2 Guided Missile.* Washington, DC: Smithsonian Institution Press, 1983.

Macrae, Norman. *The 2025 Report: A Concise History of the Future 1975-2025.* New York: Macmillan Co., 1984.

O'Leary, Brian. *The Fertile Stars: Man's Look at Space as the New Source of Food and Energy.* New York: Everest House, 1981.

O'Neill, Gerard K. *The High Frontier.* New York: Bantam Books, 1978.

Sagan, Carl, et al. *Murmurs of Earth: The Voyager Interstellar Record.* New York: Ballantine Books, 1978.

Verne, Jules. *From the Earth to the Moon and Around the Moon.* New York: Dodd and Mead, 1962.

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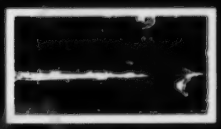

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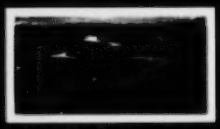

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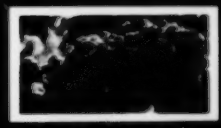

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